Six-Minute Walk Test (6MWT)

November 2020

Six-Minute Walk Test

INTRODUCTION:

We first introduced the Six-Minute Walk Test (6MWT) as an assessment in Spinal Muscular Atrophy (SMA) in 2008. A protocol was established and published in 2013. After 12 years of administration and experience, the Pediatric Neuromuscular Clinical Research Network (PNCR) for SMA (USA) in collaboration with the International SMA Consortium (UK and Italy) has led the effort to revise the 6MWT manual to provide further description, clarification and refinement of test administration, procedures, and calculations based on the lessons learned from clinical use and therapeutic trials in SMA. This updated manual version 2020 supports the original 2013 PNCR manual. We are confident testing conducted using the original 2013 manual is still valid and comparable. This updated manual provides further explanations and descriptions to support clinical evaluators across the world to maintain consistency of administration and calculation of the 6MWT for ambulatory SMA.

BACKGROUND:

The 6MWT is an objective evaluation of functional exercise capacity which measures the distance a person can walk quickly in six minutes.[1] It is a global measure of multiple body systems including cardiopulmonary, vascular and neuromuscular systems. It is easily administered and requires no special equipment or training. The person is instructed to walk at their own pace, on a defined 25 meter linear course, in an open hallway, and can stop and rest as needed. Of functional measures used in cardiopulmonary care, the 6MWT is best tolerated and most representative of a person's ability to perform activities of daily living because the intensity of the test is self-selected.[2] Although originally developed for use in cardiorespiratory disorders, the 6MWT has been used to assess function in neurological disorders such as Parkinson's disease,[3] stroke,[4] Duchenne Muscular Dystrophy,[5] and cerebral palsy.[6] More recently, it has been used as a primary endpoint in clinical trials in neuromuscular disease and for regulatory approval determination.[7, 8],[9] Following procedures outlined in the ATS guidelines for administering the test, the 6MWT is feasible in all age groups with normative data in children as young as 3 years old.[10]

Validity and Reliability

Assessments of walking ability are clinically relevant and shown to be a valid and reliable functional outcome measure in children and adults with SMA.[11] Performance on the 6MWT correlates with measures of strength and motor function, demonstrates good test-retest reliability[11, 12] and discriminates between stronger and weaker individuals.[13] Minimal detectable changes were similar to other disorders[14, 15] and ranged from 21-24 meters depending on SMA subtype.[11] In addition to a measurement of ambulatory function, the 6MWT represents functional

exercise capacity in SMA. Although originally designed as a submaximal assessment, it is thought to be a maximal test for individuals with SMA who walk <300 meters.[11]

Longitudinal Experience

Longitudinal studies have demonstrated minimal changes in the 6MWT over a 12-month period in a small, mixed cohort of children and adults.[16] While the majority of individuals had minimal changes, bigger changes were seen in children between the ages of 6 and 16 in this study. More recently, in a larger cohort, ambulant SMA individuals were found to have different disease trajectories based on age.[13] Ambulant individuals with SMA have improving walking ability until about age 6 years, a slowly declining phase until adolescence, then a more steep decline around puberty and until 20 years, after which there is another slowly declining phase through adulthood. The age around puberty appeared to be the most vulnerable period in ambulant individuals, as also observed in our previous study using gross motor function scales.[17]

Fatigue

Physiologic fatigue is the decline in one or more aspects of performance during a continuous or prolonged task.[18] In addition to an assessment of function, the 6MWT detects physiologic fatigue in SMA. Fatigue was demonstrated by a 17% decrease in gait velocity from the first minute to the last during the 6MWT.[19] Walking velocity and stride length during the 6MWT deteriorate in SMA but not in healthy individuals.[20] Decreases in stride length and EMG amplitude of key muscle groups confirmed fatigue during the 6MWT in individuals with SMA.[21] This phenomenon was not observed in individuals with other neuromuscular conditions[22, 23] and weakness, despite similar dysfunction, perhaps representative of a mechanistic defect of neurotransmission unique to SMA.[22] In studies evaluating neuromuscular junction (NMJ) function and transmission, individuals with SMA had dysfunction at the NMJ using repetitive nerve stimulation[24] and in a separate study was related to decrement in performance during the 6MWT.[25]

Clinical Trial Experience in SMA

The 6MWT has been used as a primary[26] and secondary outcome measure[27] in studies evaluating the effectiveness of exercise in ambulant individuals with SMA. In an open-label phase 2 study of children treated with nusinersen, clinically meaningful improvements in walking distance on the 6MWT were observed with modest decreases or stabilization of fatigue.[9] With the approval and availability of nusinersen for adults, the 6MWT has also recently been used to evaluate responsiveness to commercially treated individauls.[28, 29]

GENERAL TESTING PROCEDURES:

Intended population

The 6MWT is intended to be used in assessing ambulatory function of people with SMA and other neuromuscular conditions. It can be performed safely in individuals without an assistive

device. Individuals should be able to walk without support independently and be able to follow directions throughout the test. The 6MWT can be performed in children typically above 3 years of age. It is also a good assessment to evaluate "new walkers" or individuals gaining new motor milestones and to monitor development and progress.

Clinical Evaluator/Assessor

It is recommended that at least two people administer the 6MWT. At least one person, the clinical evaluator, should be a clinician, such as a physical therapist, who is familiar with gait, safety and guarding, to monitor the individual and mark each minute distance. Parent or caregiver cannot take this role. The clinical evaluator should walk safely behind the individual and avoid influencing the walking pace (chasing is not allowed).

The second person, the assessor, should be able to use the stopwatch to record the time at which the 25-meter mark is passed on each occasion, and call out the time at each 1-minute time point and provide standardized cues throughout the test.

Clinical Evaluation

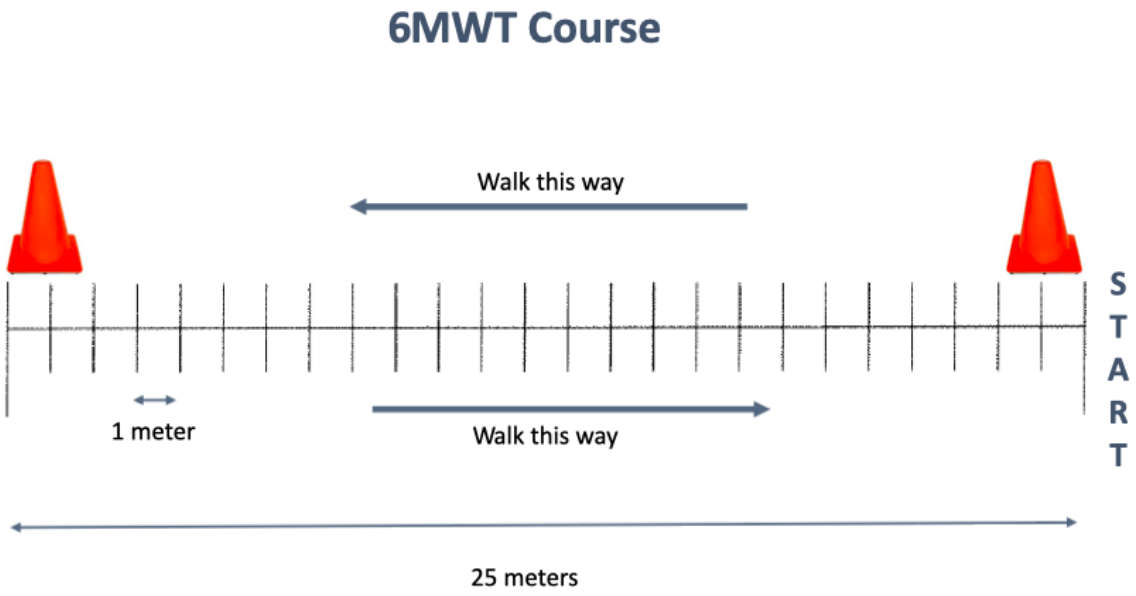
The assessor who is recording time should start the stopwatch on the word, "Go" and stop the stopwatch on the word, "Stop" when six minutes have been reached. At each minute, the clinical evaluator walking behind the child should place a post it flag behind the heel of the posterior foot.

When the test is complete, total distance walked and minute distances will be calculated using the labeled minute distance post it flags.

This test should be performed at standard of care visits at a frequency of no more than every 4-6 months. A test may be repeated at the same visit with appropriate rest provided and under the best judgement of the clinical evaluator if the first test is considered invalid due to poor behavior, distractions in the environment, shoes coming untied, or other circumstances that have impacted performance. The 6MWT should not be repeated if the first test is valid.

It is recommended that individuals being tested walk at a self-selected walking speed. The testing hallway should be safe, quiet, and clear of distractions, obstacles, and other people. Resting is permitted against the wall if necessary.

THE TESTING COURSE:



The fixed distance of 25 meters (82 feet) is marked in the testing room or hallway floor with tape. The preferred floor is a tile or linoleum surface, but a carpet surface may be used if that is the only surface available. A start line, up to 18 inches in length, should be placed horizontally at the beginning of the marked distance line. Using a contrasting color tape, mark horizontal lines every 1 meter, as shown in the diagram above. One small cone should be placed at each end of the distance line to indicate turn around points. The outer border of the cones should be aligned with the 25 meter mark to avoid extending the course length.

Required Equipment

1. Corridor at least 30 meters long (tile or linoleum floor preferred)
    a. Course itself is 25 meters plus space to turn around the cones
    b. Hallway width should be at least 2 meters wide so that one can walk and turn without touching the wall
2. Course Measurement
    a. Floor markings (not required): Should be placed at each meter marked for 25 meters embedded within tile design or using masking or duct tape
    b. Flexible 25 meter measuring tape can be used to identify course boundaries and meter marks

3. Stop watch

4. Two small cones

5. Small post-it flags – labeled 1 through 6

6. Clinical Evaluator/Assessor

   a. Clinical Evaluator: person to mark each minute distance with post-it flags and monitor the individual

   b. Assessor: person to record times and use stop watch

7. 6MWT proforma

TEST PREPARATION:

Before you start

Individuals should be comfortably dressed with appropriate shoes for walking. Assistive devices are not permitted such as ankle braces (ie. AFOs, SMOs) walkers, crutches, or canes. Shoe inserts or orthotics that do not go above the ankle are permitted (ie. UCBLs). Only those individuals who can walk safely, without assistance, should be permitted to do the 6MWT. When feasible, it is best to not have the parents present when testing children. A resting period of 10 minutes should always be given prior to the start of the test. An opportunity to use the toilet should be given.

Instruct the participant as follows

"The object of this test is to walk as far as possible for 6 minutes. You will walk back and forth in this hallway. Six minutes is a long time to walk, so you will be exerting yourself.

You will probably get out of breath or become exhausted. You are permitted to slow down, to stop, and to rest as necessary. You may lean against the wall while resting, but resume walking as soon as you are able.

You will be walking back and forth around the cones. *You should pivot briskly around the cones and continue back the other way without hesitation.*

Remember that the object is to ***walk as far as possible for 6 minutes, but don't run or jog.***

TEST ADMINISTRATION:

Briefly, demonstrate the process of walking around the cones. Ask the individual to stand quietly with toes at the starting line. Instruct the individual to start walking on the command "Go." Start the stopwatch.

Each time the individual turns around a cone and completes a ½ lap around the marked course, record the time for that 25m distance. The assessor using the stopwatch should call out each minute interval (ie. 1-minute, 2- minute). The clinical evaluator should mark the minute distance with a labeled post-it flag.

Use standard encouragement for each individual (adopted from ATS guidelines).

- At 1 minute: "*You are doing well. You have 5 minutes to go*."
- At 2 minutes: "*Keep up the good work. You have 4 minutes to go*."
- At 3 minutes: "*You are doing well. You are halfway done*."
- At 4 minutes: "*Keep up the good work. You have only 2 minutes left*."
- At 5 minutes: "*You are doing well. You have only 1 minute to go*."

Do not use other words of encouragement or body language to speed up the individual.

If the individual needs cues to stay on task or they are not giving his/her best performance, provide the minimal amount of direction or encouragement necessary. Below are a few suggested phrases, spoken in even tones:

"Remember the goal is to walk as fast as you can throughout the test."

"Walk along-side the line on the floor."

"Focus on the path you're supposed to walk."

"You are doing great, keep it up."

If the individual falls, the clinical evaluator should ask if they are able to resume, for example:

- "*Are you okay? Are you hurt? Are you able to continue?*"

If, after a fall, the individual is unable to resume standing without assistance, you are allowed to help them to stand up and the test will be continued. The <u>time should not be stopped</u> during the fall.

If, after a fall the individual is injured or unable to continue walking, bring a wheelchair over for him or her to sit on, discontinue the walk, and note on the worksheet the distance, the time stopped, and the reason for stopping prematurely.

If the individual stops walking during the test, the clinical evaluator should say:

- "*You can lean against the wall if you'd like; then continue walking whenever you feel able*."

Do not stop the timer. The individual may remain standing for the duration of the test, if they are able.

When 6 minutes is reached, say: *"Stop!"* Walk over to the individual. Consider taking the chair if they look exhausted. Mark the spot where they stopped with the labeled post-it flag.

Stopping the test before 6 minutes

The test is discontinued when the individual requires the need to sit down during the 6 minutes. If the individual stops before the 6 minutes are up and refuses to continue (or you decide that they should not continue), wheel the chair over for them to sit on, discontinue the walk, and note on the worksheet the distance, the time stopped, and the reason for stopping prematurely. A test may be repeated at the same visit with appropriate rest provided and under the best judgement of the clinical evaluator.

Determining Test Validity

A valid test is one in which an individual completes the test as intended and is able to follow directions for the duration of the test. Use your best judgement if an individual, especially children, require excessive cueing, beyond what is considered standard. No running is allowed. It is recommended that parents are not involved and do not encourage or motivate their child. Assistive devices are not permitted as well as external support or assistance from the clinical evaluator or using the wall while walking. Hands should be free from pockets. Good walking shoes, such as sneakers should be worn, with only sub malleolar orthotics if needed. On the proforma, the clinical evaluator should include comments on how behavior, participation, and overall well-being of the individual may have influenced performance.

The test is terminated and is incomplete if an individual sits down during the 6 minutes. If the individual requires excessive cueing (verbal or visual) beyond what is considered standard, does not understand the task, cannot maintain walking on the course, fails to follow instructions, or is uncooperative, the test is considered invalid.

CALCULATING DISTANCES AND FATIGUE:

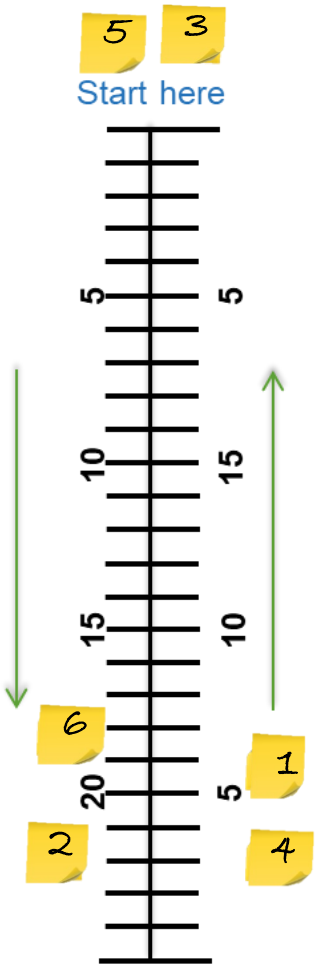
Total Distance Walked

After the test is completed, the clinical evaluator or assessor should locate the labeled 6 minute distance post-it flag and measure the distance from the last cone to the stopping point. If the post-it flag is ≥0.5 meters, round up to the next meter. Multiply the number of completed laps by 25, and add the distance reached on the final lap. This is recorded on the proforma as the total distance walked in 6 minutes. Less distance covered in 6 minutes indicates worse function.

Minute Distances

Using the times at each 25m interval, determine and then record the cumulative distance walked at each minute. Sample for minute 1 distance below:

Lap	Distance (Meters)	Time	Lap	Distance (Meters)	Time
1	25	___ : 15__	14	350	__5_ : 00_
2	50	___ : 32_	15	375	__5_ : 23 _
3	75	___ : 52_	16	400	__5_ : 45_
4	100	__1_ : 18_	17	425	___ : ___ ___
5	125	__2_ : 05_	18	450	___ : ___ ___
6	150	___2 : 20_	19	475	___ : ___ ___
7	175	__2_ : 40	20	500	___ : ___ ___
8	200	__3_ : 00_	21	525	___ : ___ ___
9	225	__3_ : 20_	22	550	___ : ___ ___
10	250	__3_ : 35_	23	575	___ : ___ ___
11	275	_3__ : 55_	24	600	___ : ___ ___
12	300	__4_ : 15_	25	625	___ : ___ ___
13	325	__4_ : 35__	26	650	___ : ___ ___



1 Minute Distance (m):

75 m+ 6 m = 81 m

Percent Fatigue

Fatigue is determined as the difference in the distance walked during the first and last test minute expressed as a percent change, where a positive value represents fatigue. Fatigue calculation and sample is below:

$$\frac{\text{(first minute distance) – (last minute distance)}}{\text{(first minute distance)}} * 100$$

Minute 1	Minute 2	Minute 3	Minute 4	Minute 5	Minute 6
100 m	95 m	90 m	85 m	80 m	75 m

$$\frac{\text{(minute 1) – (minute 6)}}{\text{(minute 1)}} *100$$

$$\frac{\text{(100) – (75)}}{\text{(100)}} *100$$

0.25*100 = **25%**

Percent Predicted 6MWT Distance

The percent of the predicted distance on the 6MWT can be computed from normative values. The predicted distance for their gender, age, height, and weight, can provide a comparison to the healthy population and represent a varied range of walking impairment and/or diminished walking ability. Recently collected reference values, using a similar standardized administration protocol in children and adults from 3 to 100 is recommended.[30]

A calculator to determine percent fatigue and percent predicted 6MWT distance is available using this link: 6 MWT Calculator | STEPIN-SMA

ACKNOWLEDGMENTS:

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PNCR – Network for SMA	6-Minute Walk Test Proforma	rev. Nov/20

Name / ID:	**Diagnosis:**
Date of Birth:	**Date of Assessment:**
Age:	**Clinical Evaluator:**
Height: ☐ cm ☐ in	**Weight:** ☐ kg ☐ lbs
Footwear: ☐ Rubber soled shoes (preferred) ☐ Barefoot ☐ Other:	**Orthoses:** Foot: ☐ Yes ☐ No ☐ Type (below malleoli permitted): Trunk: ☐ Yes ☐ No
Flooring: ☐ Tile / linoleum (preferred) ☐ Hardwood ☐ Cement ☐ Carpet ☐ Other:	

Lap	Distance (Meters)	Time		Lap	Distance (Meters)	Time		Lap	Distance (Meters)	Time
1	25	___ : ___ ___		12	300	___ : ___ ___		23	575	___ : ___ ___
2	50	___ : ___ ___		13	325	___ : ___ ___		24	600	___ : ___ ___
3	75	___ : ___ ___		14	350	___ : ___ ___		25	625	___ : ___ ___
4	100	___ : ___ ___		15	375	___ : ___ ___		26	650	___ : ___ ___
5	125	___ : ___ ___		16	400	___ : ___ ___		27	675	___ : ___ ___
6	150	___ : ___ ___		17	425	___ : ___ ___		28	700	___ : ___ ___
7	175	___ : ___ ___		18	450	___ : ___ ___		29	725	___ : ___ ___
8	200	___ : ___ ___		19	475	___ : ___ ___		30	750	___ : ___ ___
9	225	___ : ___ ___		20	500	___ : ___ ___		31	775	___ : ___ ___
10	250	___ : ___ ___		21	525	___ : ___ ___		32	800	___ : ___ ___
11	275	___ : ___ ___		22	550	___ : ___ ___		END		

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Name / ID:	Date of Birth:

Cumulative Minute Distance Walked (Meters)			
1 Minute Distance (M)	____ ____ ____	4 Minute Distance (M)	____ ____ ____
2 Minute Distance (M)	____ ____ ____	5 Minute Distance (M)	____ ____ ____
3 Minute Distance (M)	____ ____ ____	6 Minute Distance (M)	____ ____ ____

Post-Test Information

Did the participant fall? ☐ Yes ☐ No If yes, how many times? ☐ 1 ☐ > 1
Comments:

Was the test completed? ☐ Yes ☐ No
If no, what was the reason: ☐ Fell and unable to continue ☐ Sat down ☐ Other, explain:

Was the test valid? ☐ Yes ☐ No
If not, what was the reason?

Additional comments (i.e. behavior, participation, and overall well-being):

Clinical Evaluator / Assessor Information

Name of Clinical Evaluator:

Signature of Clinical Evaluator:

Name of Assessor: